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New Haven, Connecticut

LEGEND FOR SOCIETY OF AMERICAN FORESTERS FOREST COVER TYPES FOR THE EASTERN UNITED STATES

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L. H. Reineke

1/ Maintained in New Haven, Connecticut, in cooperation with Yale University

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LEGEND FOR SOCIETY OF AMERICAN FORESTERS

FOREST COVER TYPES FOR THE EASTERN UNITED STATES

The term "forest cover type" is the forester's device for tersely denoting a more or less complex association of forest trees resulting from various interacting physiological forces, species compatabilities, and climatic factors. Such forest cover types are given distinctive short names for definite designation of the various types. Since types have not always distinct characteristics, merging one into another, unnecessarily numerous names have risen through establishment of minor variants as individual types, through local usage, or through differences in view-point of separate authors of names for the same plant association.

The profusion and confusion of type names led to the preparation of a codified list of forest cover types for the eastern United States. 1/ This codification of the principles of type naming and descriptions of the various types recognized provides the forester with a simplified nomenclature having definite meaning. Adherence to the names and principles established will retain the precise significance which now attaches to these type names.

Forest types often may be referred to by name (or number) but geographical location of forest cover types is shown best by maps, whereon names or numbers are unsuitable and inadequate for striking presentation. Symbols adapted to map use are a desirable adjunct to the type names and numbers, and a standard set of symbols is in all respects as important as a standard set of names, constituting another step toward the end objective of consistent type maps for the whole territory.

This article presents a set of symbols to complement the Society's list of type names. Even as the Society's classification of types is premised on basic physiologic consideration, so does the symbolism used herein go beyond the mere mechanics of graphical distinctions and drafting materials. The basis for the symbolism will be treated in some detail.

1/ Committee on Forest Types, Society of American Foresters, 1932. Forest cover types of the eastern United States. Jour. For., 30:451-498. 1932

Each symbol of any given legend should be distinctively different from all other symbols of the series. This is a prime requisite; without it no legend can depict satisfactorily the information it represents. Moreover, more graphic differentiation of assorted variants should not be the sole objective of a legend. Where the classification is progressive in character, symbols should differ progressively. Where the classification consists of several associated series of sub-classes, this fact should be indicated by proper choice of symbols.

Intelligent selection of symbols therefore requires an understanding of the constituent parts of symbols in general.

SYMBOL MAKE UP

Fundamentally, the components of a symbol are:

Color (Color proper--green, blue, etc.
(Intensity--light, medium, dark
(Surface--transparent or opaque, pastel or glossy

and

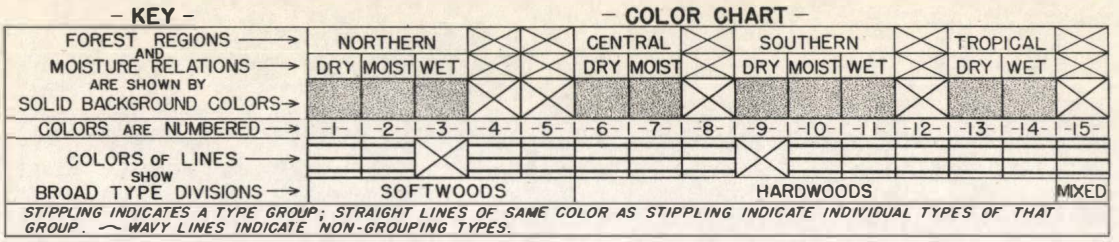
Pattern (Elements--dots, bands, lines, solid color
(Form--straight or wavy lines, square or round dots, etc.
(Arrangement--sequence and direction

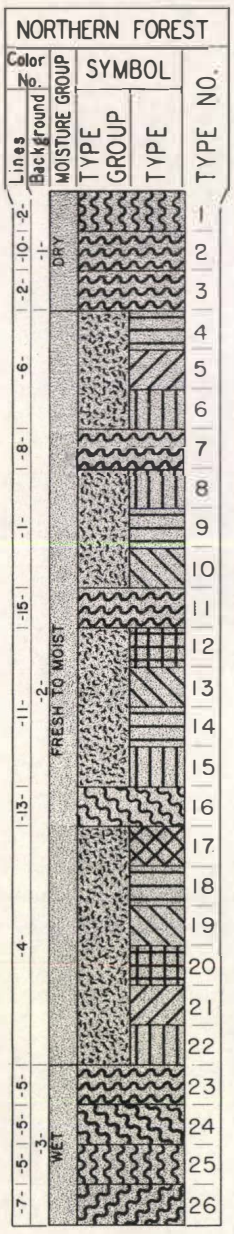
Obviously, innumerable combinations of two or more of these various components may be made, but the effectiveness of each combination will depend on the contrast it makes with all others used in company with it. Commonly, the selection of a short series of effective symbols is more or less haphazard or follows some very simple system. Solid colors may be selected, or straight black lines of varying direction may be used. Small legends so derived present no problem in translation of symbols, but multiplicity of symbols introduces a real problem in the effective identification or translation of symbols. Legends with many symbols therefore require a systematic basis to insure both maximum contrast and greatest ease in use.

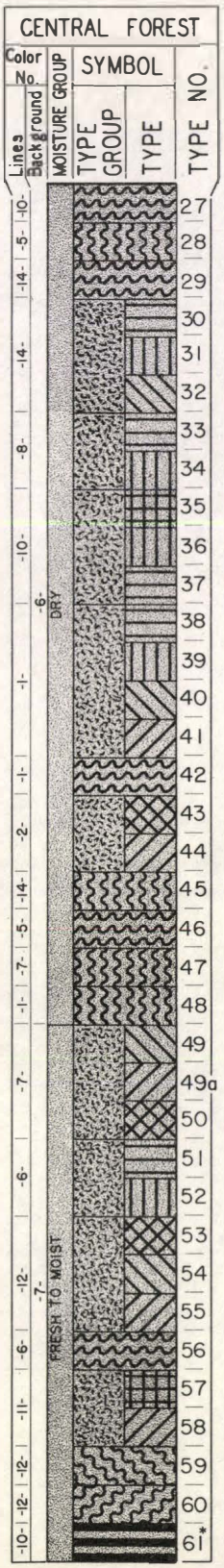
The Society's list of forest cover types includes 100 types (including 14a, 49a, and 59a). These types are divided into four forest regions and ten moisture relation groups, and 41 of the individual types are regrouped into 16 broader type groups. All this information is useful, and its embodiment in the legend is desirable provided effectiveness is not impaired. Many combinations of the symbol components given above would yield a group of 100 distinctive symbols, but a map employing a random series would be difficult to read and interpret since all symbols probably would not be memorized and location of any symbol in the legend accompanying the maps would be somewhat difficult.

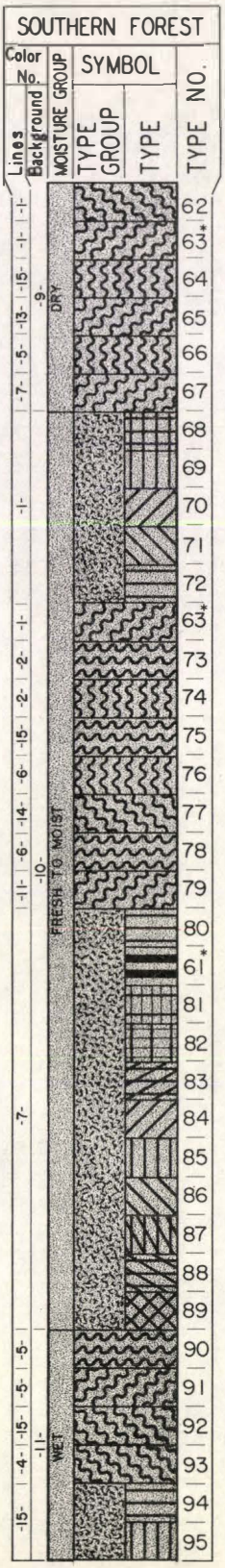
LEGEND

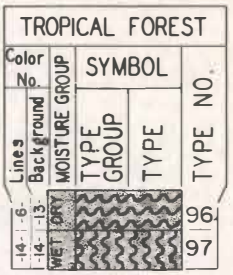
FOREST COVER TYPES OF THE EASTERN UNITED STATES

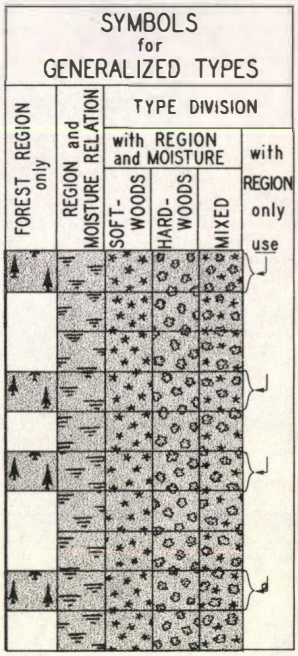

- KEY -
- COLOR CHART -
FOREST REGIONS AND MOISTURE RELATIONS ARE SHOWN BY SOLID BACKGROUND COLORS
NORTHERN
CENTRAL
SOUTHERN
TROPICAL
DRY MOIST WET
DRY MOIST
DRY MOIST WET
DRY WET
COLORS ARE NUMBERED
-1- -2- -3- -4- -5- -6- -7- -8- -9- -10- -11- -12- -13- -14- -15-
COLORS OF LINES SHOW BROAD TYPE DIVISIONS
SOFTWOODS
HARDWOODS
MIXED
STIPPLING INDICATES A TYPE GROUP; STRAIGHT LINES OF SAME COLOR AS STIPPLING INDICATE INDIVIDUAL TYPES OF THAT GROUP. ~ WAVY LINES INDICATE NON-GROUPING TYPES.

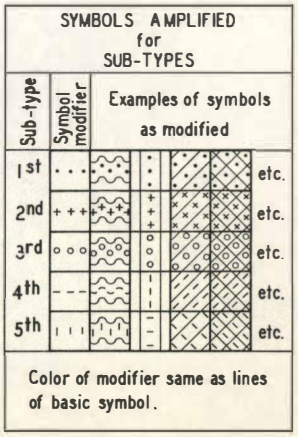


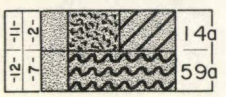

CENTRAL FOREST
Color No.
Lines
Background
MOISTURE GROUP
SYMBOL
TYPE GROUP
TYPE
TYPE NO.
DRY
FRESH TO MOIST
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 49a 50 51 52 53 54 55 56 57 58 59 60 61*


SOUTHERN FOREST
Color No.
Lines
Background
MOISTURE GROUP
SYMBOL
TYPE GROUP
TYPE
TYPE NO.
DRY
FRESH TO MOIST
WET
62 63* 64 65 66 67 68 69 70 71 72 63* 73 74 75 76 77 78 79 80 61* 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95









* This type shown twice.

FIGURE 1

It is entirely feasible to design a series of symbols which can be used in the manner of an identification key, by progressive selection and elimination, in which each symbol component--color, line form and direction, etc.--is altered progressively. Furthermore, by assigning a definite type of symbol component to a group of related individual types the resulting symbols will impart information for a group as well as for an individual type. This is the basis on which the legend presented in Figure 1 was developed.

SYMBOL CHOICE

Because of the large number of symbols needed, variations of pattern alone would not provide adequate contrasts, thereby requiring color as an added component of the symbol. Color may be introduced into the pattern itself, and the pattern may be superimposed on a background of solid color. Each treatment increases the contrasts and widens the variety of symbols available.

The forester, primarily concerned with forest areas, may have an interest in nonforest areas also. For his purposes, however, the classification of such nonforest areas need not be so elaborate as his classification of forest types. To depict such nonforest areas on a map, a relatively short series of symbols should suffice, such as could be developed by the use of pattern alone or color alone, and symbols of such a nature automatically could indicate nonforest areas.

A COLORED PATTERN ON A COLORED BACKGROUND SIGNIFIES A FOREST AREA

To avoid conflict with needs for classification of nonforest land and to permit ready distinction between forest and nonforest areas, all forest-type symbols consist of a colored pattern on a colored background. This permits the use for nonforest areas of solid colors, of colored-line patterns (white background), or of black and white patterns. Accordingly, a colored pattern on a colored background signifies "forest area".

COLOR-SERIES OF BACKGROUND DENOTES FOREST REGION

Four general forest regions are recognized in the type list. These regions can be signified by one component of the symbol, such as background color, which by its complete coverage is best adapted to show broad forest regions. Accordingly, the color-series of the background signifies the forest region, with the blue-green series, suggestive of the cool, wet, coniferous forest, for the northern forest, the warmer reds for the central forest, the yellows, suggestive of the hot, dry regions, for the southern forest, and the "well-done" browns for the tropical forest.

1/ The origin legend in color is here reproduced in black and white to show patterns, with line and background colors specified by number. Kodachrome slides (2x2 in.) reproducing the legend in full color may be obtained through the Northeastern Forest Experiment Station.

SHADE OF BACKGROUND COLOR DENOTES MOISTURE RELATIONSHIP

Within each forest region the types are arrayed and grouped in the type list by moisture relations. Since those groups are few (two or three per region), variations of background color can signify the moisture relations. Accordingly, the light, friable soils of a dry site suggest using a light shade of the background color-series assigned each forest region to signify the dry sites, a medium shade the "fresh to moist" sites, and a dark shade suggestive of dark, heavy, wet soils to denote the wet sites. Thus, in the yellow series denoting the southern forest, lemon yellow signifies "dry", golden yellow signifies "fresh to moist", and orange signifies "wet" moisture relationships.

STRAIGHT-LINE PATTERNS DENOTE INDIVIDUALS OF TYPE GROUPS; STIPPLING DENOTES THE ENTIRE GROUP

The types within the moisture relation groups have one further seriate distinction in the classification used. Certain types may be grouped together to form a broader type. To show this distinction, some attribute of the colored pattern component of the symbols must be used since both attributes of the background color component--color series and shade--have been assigned.

Colored patterns provide opportunity for manifold variations. For a given pattern, color may be varied; for a given color, pattern elements may be varied, both in form and arrangement. A pattern of lines is easiest to draft, and many contrasts are possible through spacing and direction of lines, through combination of two series of lines at an angle, and through variation in form of line--solid or broken, straight or wavy, wide or narrow.

Solid straight lines can provide the greatest number of easily drafted, distinct contrasts, due to the possibility of using two sets of lines at an angle. This type of pattern is therefore desirable for indicating the separate types of a group, since the number of types entering a group reaches a maximum of eleven. It is thus possible to keep the color of the pattern constant for any group, thereby permitting the use of another pattern of the same color to represent the group in toto.

Accordingly, stippling (indicative that individual types are scrambled and cannot be disassociated) will be used to represent grouped types, the color of the stippling 1/ differing between groups. When the separate types of the group are to be shown, straight-line patterns having the same color as the stippling will be used. The straight-line patterns will then signify that the type is one which enters a group, and the line color 1/ will identify the group.

1/ In combination with background color, of course.

WAVY-LINE PATTERNS DENOTE NONGROUPING TYPES

The remaining types, which do not enter type groups, will be indicated by wavy-line patterns, the wavy line signifying that the type is not one of a group. Recourse to intersecting sets of wavy lines is unnecessary, since direction and color of line provide adequate contrasts for the maximum of eight nongrouping types having the same background color.

COLOR-SERIES OF PATTERN DISTINGUISHES CONIFEROUS, HARDWOOD, AND MIXED TYPES

Color of pattern has not been specifically allocated as yet, beyond specifying it be uniform within a type group. The type groups were the last of the seriate subdivisions of the type list, but three further broad classes can be recognized, coniferous types, hardwood types, and mixed coniferous-hardwood types. These classes can be assigned pattern colors. Greens--suggestive of evergreens--and blues (nearest spectral color) designate coniferous types, while the reds, yellows, and browns, suggestive of hardwood fall coloring, designate hardwood types. For mixed coniferous hardwood types such as 92, 94, and 95 an olive green is used as well as for No. 11 (hemlock) which is often placed in the same category as hardwoods.

SYMBOL CONTRASTS

The pattern colors and line directions ultimately selected were designed to give maximum contrast. For example, although line colors of types 7 and 26 have little contrast, background color adds some contrast and line direction positively differentiates the two. Among the northern forest types, the line direction of type 16 is repeated in type 24 only, but here the associated background and line colors both provide good contrast. Likewise, types 7 and 56, although similar in pattern and low in line color contrast, have high contrast between backgrounds. Types 47 and 56, low in color contrasts, have high contrast in line direction. This development of positive contrast within and between forest regions extends through the entire legend, one or more components of each symbol providing strong contrast with all other symbols.

EXCEPTIONS

Two exceptions to the general plan were necessary where types overlap in forest region or moisture relation. Type 61 (Cottonwood) is listed under two forest regions-- Central and Southern (inserted between 80 and 81)-- and is represented by alternating bands of the two background colors. These bands are straight, since type 61 is listed as one of the Flood-plains group. The second exception was required with type 63 (Longleaf pine) listed under both "Dry" and "Fresh-to-moist" moisture relations. Here the symbols differ in shade of background color, but the retention of the green

line to signify coniferous type was considered generally to be preferable to using alternating wavy bands of the two shades of yellow background. The spacing of lines was kept uniform (except in 81 and 82) so that each pattern would be equally legible for map areas as small as 1/4 inch square.

LOCATION OF SPECIFIC TYPE SYMBOL

Determination of proper symbol for any type number is simple, since all symbols are listed in numerical order with the exception of the second appearance of 61 between 80 and 81, the second symbol for 63 1/ between 72 and 73, and the appended symbols for 14a and 59a added to the type list since the legend was formulated.

KEY-WISE USE OF THE LEGEND

Determination of type number from symbol should take the following key-wise procedure:

Note the color series of background (green-blue, reds, yellows, or browns) and select corresponding forest region column of symbols (1 of 4 choices).

Note the shade of background color and select moisture relation section of column having this shade (1 of 2 or 3 choices).

Note whether pattern is

1. Stippling--then identify type group by color of stippling (1 of 1 to 5 choices).
2. Straight lines--then select type group by color of line and identify type by pattern of lines (1 of 2 to 11 choices).
3. Wavy lines--identify type by line direction and color (1 of 1 to 8 choices).

LEGEND MODIFICATIONS

Any legend for an all-inclusive list such as this type list should permit both generalization and refinement. Generalized symbols are shown at center right of Figure I. The legend can be generalized to show only forest regions by using the lightest shade of the background color series for each region with a pattern of conventionalized "trees" of the darkest shade of background color for the region. Region and moisture relation types collectively can be shown by using the various shades of background colors with a pattern of blue lines (color 4). Distribution of collective softwood, hardwood, or mixed

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1/ The choice of symbols for type 63 must be based on classification of moisture relation in the field or by allocation in accordance with "occurrence" under the type 63 description.

types can be shown by conventional softwood symbol in green (color 1) for softwood, by conventional hardwood symbol in orange (color 11) for hardwood, and interspersed conventional symbols in olive green (color 15) for mixed types, the pattern characters being randomly--and widely--spaced. Naturally, if particular interest centers in an individual type the appropriate symbol for that type would be used and the generalized symbols applied to the remainder of the area.

Refinement of symbols for intensive type classification of small areas on large-scale maps may be accomplished in several ways without changing the general character of the symbol given for the type. For example, if type 7 (gray birch-red maple) is divided into one subtype in which gray birch predominates and a second subtype in which red maple predominates, the subtype symbols would consist of the type symbol with a line of dots substituted for every other solid line for the first subtype and lines of crosses for alternate lines for the second subtype. Symbol modifiers for five subtypes are indicated at the lower right of Figure 1. By substituting modifying lines, symbols are not crowded and labor is increased only by the difference between drafting of solid and discontinuous lines.

USABILITY OF THE LEGEND

It may appear on casual inspection that the set of symbols here given is so complex as to defy ready comprehension, and so it would be without its orderly basis. However, there is needed only a little study of the summarizing section headings on pages 3 to 5 to fix in mind the basic concepts on which the legend is built. Memorization of the entire detailed legend is not anticipated--hence the key-wise system for symbol identification--nor would there be many instances in which the entire legend would be utilized. For example, in type-mapping some sixty-odd towns aggregating about one million acres, in southwestern Maine, only 26 types (with 4 subtypes) were encountered, and the individual town maps seldom showed more than half this number. Since the number of symbols required for a given map is fixed by the number of types encountered, all legends are on an equal footing with respect to number of symbols actually used for a specific map. Study of a specific map, therefore, would not be complicated by the legend given here, yet the broader relationships would become apparent during detailed study of an individual map or general study of a series of such maps. Furthermore, the probable appearance of a generalized map could be anticipated from the appearance of the detailed maps.

COGNATE LEGENDS

A few suggestions may be appropriate as to correlation with the forest type legend of legends for other classifications, as for game forage types, or for nonforest types such as agricultural areas. No attempt will be made to present complete legends for such classications; rather, a few principles will be outlined for guidance to their development.

For a broad classification of nonforest land, solid colors may be employed for agricultural land, using greens for pasture, yellows for hayland, brown for cropland, and gray for urban areas (Series A, Fig. 2). Light and dark shades may be used to indicate moisture relations. For a somewhat more intensive classification, solid colors might be discarded in favor of colored-line patterns (white background only) using the same colors (Series B, Fig.2). In this series, the horizontal broken lines representing "new clearing for crops" may be converted into solid horizontal lines, suggestive of furrows, to represent tilled land. Detail as to crop may be shown by letters inserted at breaks in the lines. Idle land is represented by broken lines at right-angles to the solid lines and these broken lines may be converted into solid lines to form two series of solid lines at right-angles to indicate abandoned farmland. These cropland symbols thus can be converted progressively.

Urban areas may be shown by solid gray, or a break-down into industrial, commercial, residential, and recreational may be shown by gray-line patterns. 1/ These nonforest symbols are distinct from the forest type symbols by virtue of having a solid color without lines (Series A) or a colored line pattern without a colored background (Series B).

Brushland, intermediate between forest and agricultural land, profitably can be set off by a bright color or by a distinctive type of symbol, using a colored nonlineal pattern on a white background, as shown in Figure 2. Since brushland probably is of greatest interest to wildlife students, the symbol used should fit into a legend for cover types having particular significance from the game management standpoint. The Society's forest cover types, and the legend therefor, may meet game management needs adequately, with or without subtypes, so far as forest areas are concerned, but additional strong interest centers in minor vegetative forms, including water plants. A series of symbols, distinctive either in color or black and white, is suggested in Figure 2. Note that the brush symbols are similar to the brush symbol for the Nonforest Classification (Series B). Note, also, that grass type symbols correspond with pasture and hay land symbols.

The civil and social attributes of an area may be of interest in addition to vegetative aspects. Reservations and ownerships may merit inclusion on a given type map. The National Resources Committee 2/ gives color and line symbols for denoting reservation (or use) and ownership types. Ownerships are indicated by colored borders or by variously segmented lines. Types of reservation or use (forest, park, military, etc.) are indicated by black symbols of various forms (triangle, shield, etc.) or by solid colors covering the entire reservation. Obviously this last is unsuited for application

1/ National Resources Committee. 1937. Suggested symbols for plans, maps, and charts. Washington, D.C. Plates C-1.1 and C-2 contain suitable patterns for agricultural and urban classifications.

2/ Ibid. Plates D-3 and D-5.

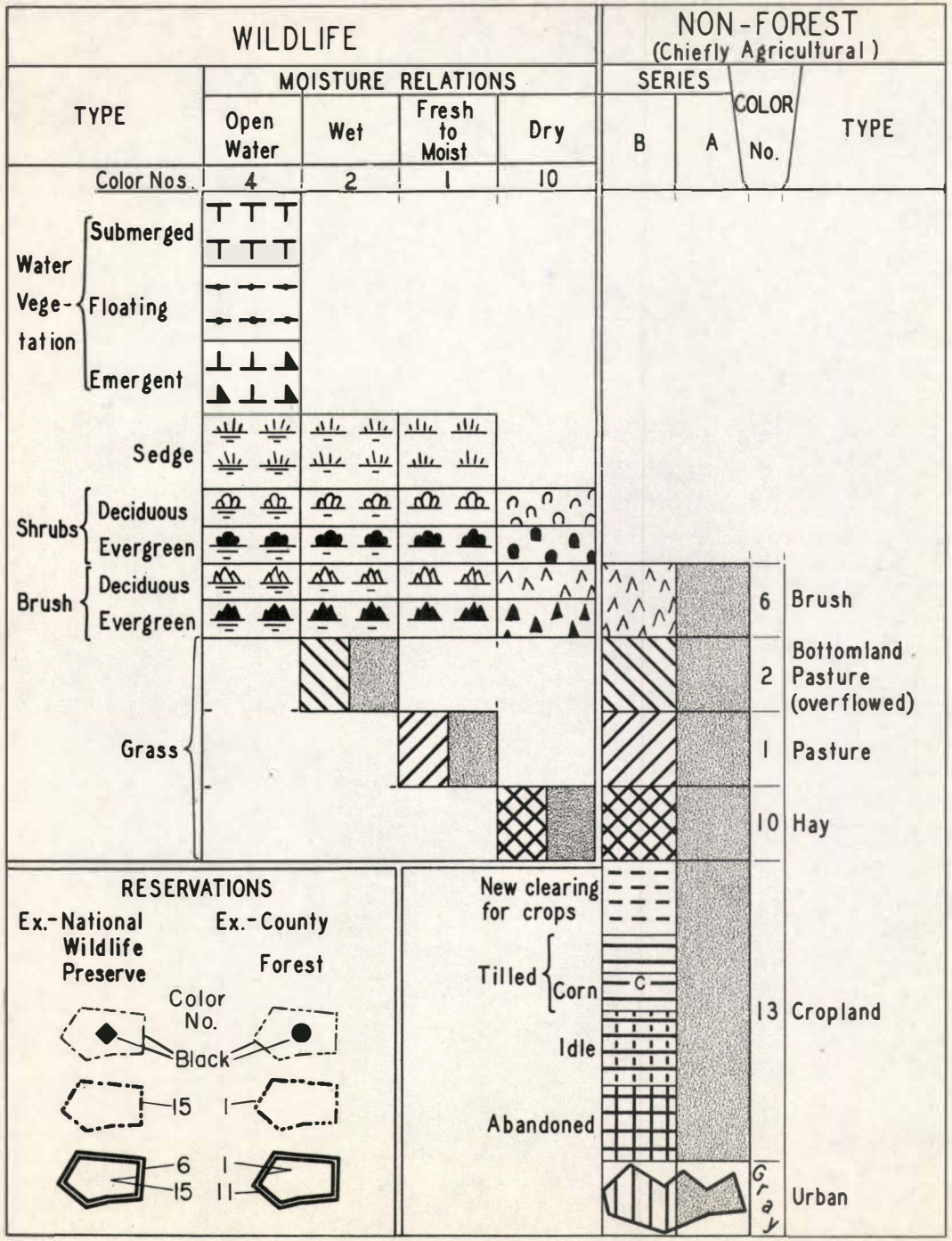

FIGURE 2

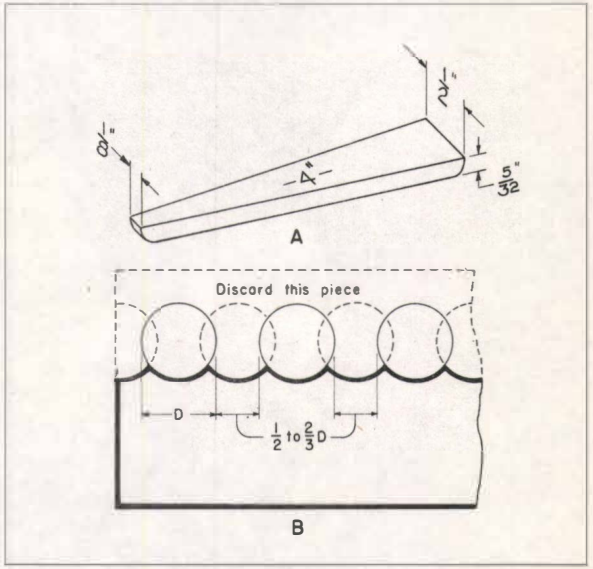

FIGURE 3

over the forest type map, but three simple methods remain for presenting such information in conformance with the symbols of the National Resources Committee. The first is the use of black lines and symbols. The second is the use of a segmented boundary in color, the color signifying use and the segmentation indicating ownership. The third representation would utilize a double colored border, the color of the inner border denoting use and the outer border color denoting ownership. Each method is illustrated in Figure 2, for a national park and for a county forest. Of course, combination presentations are possible, such as a colored segmented boundary line (both color and segmentation of line showing ownership) with a central black symbol to show use.

COLORING MATERIALS AND APPLICATION

Various coloring media are available, some of which are not suitable for map use because of opacity, difficulty of control, or slowness of drying. Transparent photo oil colors, special map inks 1/, colored pencils, and artists' drawing chalks are usable for the background colors: water colors and colored-ink washes are not particularly desirable because of the wetting of the paper.

Table 1 lists a number of coloring media, with mixing proportions or manufacturers' identification numbers for the closest match to each of the 15 colors used in the legend. Some colors do not match closely; these are indicated. Others need be applied very lightly or quite heavily, as designated, to produce a reasonably close match. Some ommissions signify nonexistence of a reasonably matching color but most are due to nonavailability of materials for test. Water colors and water-base drafting inks are omitted because of their wetting properties. Permanence of color, necessary when maps are to be exposed continuously to light, is indicated by underscoring.

Colored pencils are extremely convenient for use, especially when the coloring is done in the field, or intermittently in the office. The colored pencils are of three types--the common wax type (Dixon's Best, Unique), the indelible or water-color type (Mongol Indelible, Aquarello), and the gasoline-wetting type (Polychromos). Each type has its own technic for application to produce even background coloring. The use of gasoline or similar solvents for applying or spreading the colors is not detrimental for map coloring, but the use of water is.

Indelible pencils of the "Mongol Indelible" or "Aquarello" type, although designed for use with water, can be handled very easily without any liquid by dry-rubbing the roughly pencilled color with an artist's "stump". A tightly rolled piece of paper

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1/ Jensen, Herbert A. and Mary E. Anthony. 1937. A new map coloring process. Jour. For., 35:282-4.

Table 1.- Commercial materials for producing the legend colors.

Legend Color Number	Coloring Material[1] A[2]	B[3]	C	D	E	F	G[4]	H	I
	Proprietary number or composition of equivalent color[5]								
1	14	20 M 2 G 1 Y	848[6]	1108	1218	354½[7]	8	8587[6,8]	6608
2	19	20 M 1 DG 1 B	898	1128	1238		13		
3	17	15 M 1 G 2 B	858	1198[8]		354	17b		
4	22	10 M 1 B 1 O	845	1115	1216[7]	320[7]	19		
5	30	5 M 4 V 1 B 1 N	844	1124	1225[7]	323	22		
6	31	25 M 2 R 10 W	846	1186[7]	1217[7]	322[7]	3[7]		
7	32	20 M 4 R 1 V	864	1146[8,9]	1230[8]	323½[6,7]	15b	8584[6]	
8	48	5 M 2 R 2 FW	876[6]	1106	1212[6,8]	321½	(old no.) 15a		
9	2	150 M 1 B 30 Y 60 W	817	1117	1209	353½	2		
10	6	10 M 1 Y 2 RS	867	1107	1229	353	10[7]		6633[8]
11	9	15 M 4 O 2 S	862[6]	1112[7]	1214	324	11	8582	

towelling makes an excellent substitute. A better substitute is a 4-inch strip of 5/32 inch Tempered Masonite, 1/ 1/8 inch wide at one end and 1/2 inch wide at the other, with the rough side rounded off with sandpaper to make a double-ended burnisher (Fig. 3). The sanded surface picks up some color and spreads it evenly as the area is rubbed over; the wide end serves for large areas, the narrow end serves for small areas and for corners. The rigidity of the material retains fairly sharp edges for working close to lines, and the working surface is renewed simply by a light sanding. This burnisher produces a slight gloss not given by the paper stumps. By dry-rubbing, the indelible pencils will produce a very smooth, even color. Depth of color will depend chiefly on the pressure applied to the pencil when roughing-in the color. Light pressure will produce a light tone even if the color is laid on copiously, since the rubbing removes any excess not embedded in the grain of the paper. Too-heavy colors may be lightened by rubbing with clean paper towel wads, which pick up color quite rapidly. In using the indelible colors, the loose color dust should be blown away frequently to prevent smudging and colored areas should be protected from moist hands. Otherwise there is no difficulty in the use of indelible colored pencils.

Artist's drawing chalks, such as the "Castell Polychromes", are well suited for background colors. They can be applied in the same manner as the indelible pencils, using the Masonite rubbing strip, but applying the chalk with very light pressure. These chalks are less apt to be smudged by moist hands, but loose color dust must be blown off each section as soon as rubbing-down is complete.

Gasoline-wetting pencils, such as the "Castell Polychromes", give smooth background coloring if applied dry and rubbed down with a stump saturated with nonleaded, water-white gasoline. However, reasonably smooth coloring can result from dry rubbing.

The wax type of pencil, such as "Dixon's Best", "Unique", and many others, must be rubbed down with a stump moistened with xylene or gasoline, otherwise a streaked effect will be produced, or if enough color is applied to produce a smooth effect the desired transparency of color will be lost.

Probably the most even background coloring can be produced with transparent photo oil colors or with special map inks. Instructions for application of the oil colors is provided with the materials; for the special map inks complete details are given in reference on page 9. Maps on soft paper may have to be sized before coloring, but the process is simple and quick. Both types of coloring are easy to apply, though not quite as convenient for frequently interrupted work as chalk or pencils. When long periods can be devoted to coloring without long interruptions, the necessary mixing of colors or cleaning of brushes does not become a chore.

1/ The thicker sizes are less satisfactory, tending to separate at the ends into layers.

Table 1. (Cont'd.)

Number	A [2]	B [3]	C	D	E	F	G [4]	H	I
12	44	100 M 1 B 12 FC 60 RS	853	1133 [8]	1239 [6]	335½ [8]	4		
13	52	150 M 15 WB 30 FC 1 S	863 [6]	1193	1224 [7]	335	6		
14	55	5 M 1 FW 3 WB 4 N	893	1123		343	5		
15	11	10 M 1 G 2 FC 2 RS	888 [6]	1148	1128	325 [9]	17a		

1/ Coloring materials listed are:

A. Castell Polychromos Pencils and Chalks	A. W. Faber
B. Kodak Transparent Oil Colors	Eastman Kodak Co.
C. Mongol Colored Indelible Pencils	Eberhard Faber
D. Aquarello Water Color Pencils	Eberhard Faber
E. Venus Unique Thin Colored Lead Pencils	American Pencil Co.
F. Dixon Best Pencils	Dixon
G. Fine Inks	The California Ink Co.
H. Water-color Pencils	A. W. Faber
I. Rainbow Pencils	Eberhard Faber

2/ Pencil and drawing chalks have identical numbers.

3/ All colors nonfading. The proper mixture of colors and "Transparent Medium" is here indicated by number of parts by volume of each ingredient. The symbols are:

B Chinese Blue	M Transparent Medium	S Scarlet
DG Dark Green	N Neutral Gray	V Violet
FC Flesh Shadows Cool	O Orange	W Opaque White
FW Flesh Shadows Warm	R Rose	WB Warm Brown
G Medium Green	RS Raw Sienna	Y Yellow

4/ The numbers given are for colors compounded for the California Forest Experiment Station. See reference on page 9.

5/ Underlining of numbers indicates that the colors are nonfading.

6/ Changes color on exposure to light.

7/ Apply lightly.

8/ Poor match.

9/ Apply heavily.

LINE WIDTH AND SPACING

A very fine line does not show its color so well as a moderately wide line. Line width should be between 1/40 and 1/30 of an inch, with the space between lines about three times the width of the line. These proportions produce a good balance between background and line color and the line colors are distinct.

Colored drafting inks, colored pencils, and inks made from photo oil colors are suitable for ruling of lines. The special map inks mentioned for background colors do not make up into inks usable in pens. Good pen inks can be made from photo oil colors by diluting the color, mixed with transparent medium, with sizing fluid. A little of the special cleaning fluid for photo oil colors can be added for more rapid drying, but a large proportion of this cleaning fluid will cause the ink to spread or run badly. Each medium recommended for the lines will take well on top of each kind of background color material recommended, except that colored drafting inks should not be used over indelible or water-color pencil backgrounds, although they may be used without trouble over the other types of background coloring materials.

RULING GUIDES

The preparation of a guide for drawing the wavy lines is quite simple. A piece of fairly stiff celluloid is punched near one edge with a line of evenly spaced holes, the interval between holes being 1/2 to 2/3 their diameter (solid-line circles, Fig. 3). These intervening sections are then punched out (broken-line circles, Fig. 3) and the narrow edge discarded. The sharp points of the wavy edge may be rounded slightly with fine sandpaper, but this is not really necessary, the thick leads of colored pencils resulting in rounded crests as the pencil is drawn slowly along the guide. In spacing successive lines, the guide should be moved only in a direction at right angles to the wavy edge of the guide. Moving the guide at an angle of 45° to its wavy edge will produce a pattern with a somewhat different effect, and any irregularities in the guide will be more prominent.

PROTECTION OF FINISHED COLORS

Protection of the coloring matter from the moisture or smudging which may come from frequent handling may be desirable. Oil colors and the special map inks require no particular protection. Coloring done with colored pencils profitably can be protected by spraying with "Fixatif" or similar protective material, applying several spray coats lightly to avoid formation of drops of liquid on the map surface with consequent danger of color running. Wax-pencil colors can be "fixed" prior to spraying by placing the map face down on a clean blotter, applying water-white nonloaded gasoline or other solvent to the back of the map and rubbing gently. The blotter absorbs the solvent after it has passed through the paper and

dissolved the wax in the coloring. The map must be held firmly in contact with the blotter--any lateral movement between map and blotter may smudge the colored lines.

KEYING THE MAP

The completed map should bear an appropriate legend, of course. Presumably only those types represented on a specific map should appear in its legend. The form of such specific legends could follow that of the complete legend of Figure 1, omitting unused types or forms of symbols. Thus, for the grouping types, either the stippling or the straight-line symbol variants would be omitted, as befitting. Showing the background colors at the left of each column of symbols, as in Figure 1, would be desirable.

A concise key to the use of the legend could be incorporated. This need not be more than

A - Select symbol column by color series of background.

B - Select moisture-relation section of column by shade of background color.

C - Select type group by color of stippling or straight lines. Identify type by pattern of lines.

D - For wavy-line symbols, identify type by line direction and color.